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VEGETATION RECOVERY FOLLOWING FIRE IN AN OAKBRUSH VEGETATION MOSAIC

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Fire plays a role in maintaining ecosystem diversity, improving forage production, enhancing wildlife habitat, and recycling nutrients in the soil (Wright and Bailey 1982). Postfire succession in the Gambel oak (*Quercus gambelii*) type, however, has received less attention in the literature than most major vegetation types. The most extensive work on secondary succession in the Gambel oak type was done by McKell (1950).

In August of 1990 an intense wildfire burned nearly 3000 ac of oak-dominated vegetation in the vicinity of Wasatch Mountain State Park near Midway, Utah. This note reports on the first-year vegetation recovery in a vegetation mosaic of oakbrush and sagebrush-grass communities during the first year following that fire.

Individual study sites are located in Heber Valley near the town of Midway, Utah. All are in the lower foothill zone of the central Wasatch Mountains. Gambel oak dominates the hillside vegetation of Heber Valley and grows in a discontinuous belt extending from approximately 1500 to 2600 m elevation. Study sites lie within the ecotone near the lower margin of the scrub-oak belt and the upper margin of the foothill zone. The ecotone comprises a vegetation mosaic of open spaces and oak-clone thickets. Major shrub or tree species associated with Gambel oak include *Prunus virginiana, Acer grandidentatum, Symphoricarpos oreophilus,* and *Amelanchier alnifolia.*

Interspersed among oak-clone thickets are open spaces containing vegetation characteristic of both the mountain shrub community and the foothill zone. The interspaces characteristically support populations of *Artemisia tridentata, Purshia tridentata, Chrysothamnus viscidiflorus, Bromus tectorum,* and *Agropyron spicatum.*

Climate of the Heber Valley area is characteristically continental. Annual precipitation at the Heber City weather station averages 39 cm. Mean annual snowfall is 175 cm. Annual average daily maximum and minimum temperatures are 16.1°C and –2.6°C, respectively. The frost-free period is typically 70–80 days (USDA 1976).

One study site was selected within the burn, and a similar nearby unburned area was chosen to provide comparison. Sites were selected for similarity of elevation, aspect, slope, and soils. The burned site (T3S R4E S33 SE1/4) within an elevation range of 1771–1832 m consists of two opposing slopes, one with a generally east-facing aspect, the other generally west-facing. Variability in topography allowed for sampling across a full range (0–360°) of aspect.

The unburned site consists of a roughly circular sampling transect centered on Memorial Hill (T3S R4E S35 NE1/4). The sampling elevation ranges from 1740 to 1771 m. Slopes of both sites range from 20 to 60%. Soils consist of a complex of Hennefer silt loam and Hennefer cobbly silt loam (Pachic argixerolls; USDA 1976). Runoff is rapid on Hennefer soils and erosion hazard is considered high.

Burned and unburned sites were identified for intensive sampling and quadrat analysis. Two supplemental sites of similar slope, elevation, and topography were selected for reconnaissance survey and identified as area C (T3S R4E S21 NE1/4) and area D (T3S R4E S23 NE1/4). Comprehensive species checklists were compiled for all sites to establish whether

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the intensive study sites were representative of vegetation of the vicinity as a whole (Poreda 1992).

Sampling was done in mid-June, early August, and late September during the 1991 growing season. For the reconnaissance surveys, species were recorded as encountered while the surveyor walked arbitrarily selected transects within each of the four study areas. This permitted observation of additional species not found in the quadrats.

Quadrat sampling was conducted along transect lines established on both the burned and unburned sites. Quadrats (1.0 m^2) were marked at 30-m intervals along each transect line. The burned site contained 171 quadrats, the unburned site 39.

Cover for each species, total vegetative cover, bare soil, rock, and litter were estimated within each quadrat using a procedure slightly modified from Daubenmire (1959). The modification consisted of adding one extra cover class with limits of 0–1%. This modification provided a more accurate estimate of cover for small or subordinate species (Davis and Harper 1989). Plant densities were based on counts of individuals (by species) rooted within the 1.0-m^2 quadrats. Species frequencies were the percentage of quadrats in which a species occurred.

Values for cover-class and density were recorded for each species for each quadrat along with sampling date and community type. Species mean percent cover (%C) was computed separately for oak and shrub-grass communities (including aggregated communities) on both the burned and unburned sites. The Mann-Whitney test was used for significance testing of mean differences. Percent of total cover (%TC) of each species was expressed as a percentage of the summed maximum cover of all species. Species identification follows Arnow et al. (1980).

Total vegetative cover was substantially reduced for both communities on the burn even after one full year compared to that of the unburned site (Table 1). Changes in bare soil June through September on both unburned sites are not statistically significant ($P > .28$), nor is the change between June and September on burned shrub-grass sites ($P > .4$). On burned oak sites, however, the trend of significantly ($P = .0004$) decreasing bare soil can be attributed to the dramatic increase in vegetative cover.

Species count (Table 2) on burned shrub-grass quadrats (73) was 1.87 times the number on unburned quadrats (39). Total number of species on burned oak sites (61) was 1.33 times greater than the number on unburned sites (46). The data strongly indicate that shrub-grass sites are richer in species than oak sites, and that this relationship holds even after fire. Moreover, species diversity is higher on both communities following fire.

Many species declined in both frequency and cover following fire (Tables 3, 4). Others increased in both frequency and cover following fire. A few showed little change.

On shrub-grass sites species showing greatest decrease include *Agoseris glauca*, *Agropyron spicatum*, *Artemisia tridentata*, *Crepis acuminata*, *Lathyrus pauciflorus*, and *Lomatium triternatum*. Species increasing after

TABLE 1. Seasonal areal coverage (%C)[a] of vegetation, litter, bare soil, and exposed rock for burned and unburned sites[b].

	Shrub-grass			Oak		
	June	Aug	Sept	June	Aug	Sept
BURNED						
Vegetation	16.79	12.87	28.14	16.30	41.59	49.50
Litter	6.76	21.67	22.86	7.22	9.21	11.57
Bare soil	35.72	37.38	37.98	42.88	33.63	32.44
Rock	18.09	18.74	19.41	10.28	10.25	10.15
UNBURNED						
Vegetation	46.09	31.59	49.50	73.94	65.06	73.18
Litter	37.30	53.95	60.27	88.52	90.59	92.65
Bare soil	7.95	9.05	8.93	6.53	0.79	0.65
Rock	18.80	18.80	19.34	3.09	3.09	2.94

[a]%C expressed as mean cover based on m^2 quadrats.
[b]$n = 171$ (burned); $n = 39$ (unburned).

TABLE 2. Cumulative number of species[a] observed in sampled quadrats.

	Shrub-grass		Oak		Aggregated	
	#	%	#	%	#	%
BURNED						
Total	73	100	61	100	80	100
Annual	24	33	20	33	26	32
Forb	33	45	28	46	36	45
Grass	9	12	4	6	9	11
Shrub	7	10	9	15	9	11
UNBURNED						
Total	39	100	29	100	46	100
Annual	10	26	9	31	14	30
Forb	16	41	9	31	17	37
Grass	8	20	6	21	8	17
Shrub	5	13	5	17	7	15

[a]June through September 1991

TABLE 3. Frequency and cover for major species on shrub-grass sites.

	Unburned			Burned		
Species	Freq.	%C	%TC	Freq.	%C	%TC
Agoseris glauca	9.10	.05	.07	.00	.00	.00
Agropyron spicatum	63.60	10.31	16.04	9.80	.80	2.11
Amelanchier alnifolia	.00	.00	.00	1.60	.05	.13
Artemisia tridentata	27.30	4.59	7.15	.00	.00	.00
Aster chilensis	9.10	.16	.25	3.30	.50	1.30
Bromus tectorum	68.20	6.84	10.64	70.50	6.51	17.14
Chenopodium album	.00	.00	.00	24.60	1.41	3.72
C. leptophyllum	.00	.00	.00	19.70	.50	1.32
Collinsia parviflora	18.20	.21	.32	26.20	.34	.88
Crepis acuminatum	54.50	2.16	3.36	4.90	.07	.17
Galium aparine	4.50	.02	.04	24.60	.52	1.38
Lathyrus pauciflorus	13.60	.84	1.31	3.30	.05	.13
Lomatium triternatum	27.30	.91	1.41	4.90	.02	.06
Machaeranthera canescens	.00	.00	.00	9.80	.40	1.06
Poa pratensis	27.30	6.14	9.56	18.00	2.39	6.28
Polygonum ramosissimum	4.50	.02	.04	19.70	.26	.69
Prunus virginiana	.00	.00	.00	3.30	.30	.78
Quercus gambelii	22.70	5.49	8.55	14.80	1.59	4.17
Solidago sparsiflora	.00	.00	.00	4.90	.54	1.42
Symphoricarpos oreophilus	.00	.00	.00	4.90	.11	.28
Verbascum thapsus	.00	.00	.00	19.70	.90	2.37
Viguiera multiflora	.00	.00	.00	36.10	2.53	6.67

burning include *Chenopodium album, C. leptophyllum, Collinsia parviflora, Galium aparine, Machaeranthera canescens, Polygonum ramosissimum, Solidago sparsiflora, Verbascum thapsus,* and *Viguiera multiflora.*

Some species, such as *Aster chilensis,* may be somewhat less typical in that frequency was lower on burned shrub-grass sites, yet cover was actually greater than on unburned sites (Table 4), suggesting a response of increased size and vigor of the surviving individuals.

Relative to the unburned, *Bromus tectorum* showed little difference in frequency or cover, suggesting only a minor effect in the first year following fire; relative importance of this species was, however, enhanced due to the decline of most other species. Studies by Young and Evans (1978) suggest a potential explosive increase of *B. tectorum* in the second and third years after fire as the species rapidly colonizes space made available by fire.

On oak-dominated sites there was a similar or greater reduction of those same species exhibiting a lowered frequency on shrub-grass sites. In addition, *Aster chilensis* and *Bromus tectorum* (species showing substantial survival

TABLE 4. Frequency and cover for major species on oak-dominated sites.

Species	Unburned			Burned		
	Freq.	%C	%TC	Freq.	%C	%TC
Agoseris glauca	11.80	1.06	1.10	.90	<.01	.01
Agropyron spicatum	29.40	.59	.61	.00	.00	.00
Amelanchier alnifolia	23.50	1.09	1.13	8.10	.95	1.66
Artemisia tridentata	17.60	1.09	1.13	.00	.00	.00
Aster chilensis	5.90	.03	.03	.00	.00	.00
Bromus tectorum	23.50	4.17	4.33	18.90	.16	.28
Chenopodium album	.00	.00	.00	24.30	1.24	2.15
C. leptophyllum	5.90	.03	.03	19.80	.39	.67
Collinsia parviflora	29.40	.15	.15	27.90	.32	.56
Crepis acuminata	47.10	1.38	1.44	3.60	.02	.03
Galium aparine	11.80	.21	.21	24.30	.69	1.20
Lathyrus pauciflorus	58.80	2.59	2.68	7.20	.30	.52
Lomatium triternatum	35.30	.77	.79	1.80	.01	.02
Machaeranthera canescens	.00	.00	.00	.90	.03	.05
Poa pratensis	52.90	16.81	17.44	17.10	1.23	2.14
Polygonum ramosissimum	.00	.00	.00	6.30	.03	.05
Prunus virginiana	29.40	8.38	8.69	10.80	.84	1.46
Quercus gambelii	100.00	51.12	53.03	92.80	38.36	66.68
Solidago sparsiflora	.00	.00	.00	2.70	.19	.33
Verbascum thapsus	.00	.00	.00	19.80	1.12	1.95
Viguiera multiflora	.00	.00	.00	24.30	.86	1.49

on shrub-grass sites) were virtually eliminated from oak-dominated sites. Higher burn temperatures associated with oak-dominated vegetation were likely more damaging to these species. Shrubs most common to oak sites, *Prunus virginiana* and *Amelanchier alnifolia*, both had decreased frequencies following fire. *Amelanchier alnifolia*, however, exhibited more vigorous resprouting. Although frequency was lower on burned oak sites, cover of *A. alnifolia* one year after the burn was only slightly less on the burn site than on the unburned sites.

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